

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	}	
	}	
Revision of Part 15 of the Commission's	}	
Rules Regarding Ultra-Wideband	}	ET Docket No. 98-153
Transmission Systems	}	

PETITION FOR RECONSIDERATION (REPLY COMMENTS)

Filed by: Multispectral Solutions, Inc.
20300 Century Boulevard
Germantown, MD 20874
(301) 528-1745

Date: 29 July 2002

In recent technical discussions^{1,2}, the Office of Engineering and Technology pointed out that the rationale and measurement techniques for pulse desensitization correction (PDC) are contained in Hewlett Packard (HP) Application Note 150-2.³ This was further indicated as the basis for applying PDC to pulse waveforms under 47 CFR Part 15.35 of the Commission's rules.

HP Application Note 150-2 does indeed address the rationale for applying PDC to correctly measure total (i.e., full bandwidth) peak power using a spectrum analyzer. However, the rationale for applying PDC has nothing whatsoever to do with determining

¹ Telephone conversation between Mr. John Reed, FCC OET and Dr. Edward Richley, MSSl, 15 May 2002.

² *Ex parte* Meeting with Mr. Ed Thomas, et al. (FCC OET) and Dr. Robert Fontana and Mr. Robert Mulloy, 18 July 2002.

³ "Spectrum Analysis ... Pulsed RF", Hewlett Packard Spectrum Analyzer Series, Application Note 150-2, November 1971.

the potential for interference from pulsed devices. Rather, as pointed out in the HP application note regarding the topic of pulse desensitization,

*"Pulsing a CW carrier results in its power being distributed over a number of spectral components (carrier and sidebands). Each of these spectral components then contains only a fraction of the total power."*⁴

Indeed, the application note acknowledges that "pulsing a CW carrier", or equivalently generating a bandpass pulse response, results in "only a fraction of the total power" being present in the measurement (or, equivalently, victim receiver) bandwidth.

Hence, the only point the HP application note is making is that full bandwidth peak power, a measurement required by radar system designers to determine potential system performance, is not always equal to the power as measured in any given spectral slice. However, it is precisely this "fraction of the total power" that causes interference. That is, it is the *power spectral density* (Watts per Hz or MHz) that determines the potential to interfere.⁵

Thus, HP Application Note 150-2, as well as the record in 47 CFR Part 15.35⁵, strongly support the fact that PDC (except as expressly stated for frequencies below 1 GHz) is not required for measurements made above 1 GHz. As pointed out in MSSI's recent Petition for Reconsideration⁵, the acceptance of this fact (namely, that PDC is not required above 1 GHz) permits the rationalization that the new limits for Ultra Wideband (Part 15.501)

⁴ HP Application Note 150-2, pages 6-7.

⁵ Petition for Reconsideration, ET Docket 98-153, Multispectral Solutions, Inc., 14 June 2002 (amended 18 June 2002).

are indeed more conservative than previously existing Part 15, rather than many orders of magnitude larger.

To further clarify the problem, consider the following three signal examples:

- (a) A pulsed signal having a 2 GHz instantaneous bandwidth with a +32 dBm full bandwidth peak power operating in the 3.1 to 10.6 GHz band;
- (b) A CW carrier having a -41.25 dBm peak power operating in the 15.205 non-restricted bands; and,
- (c) A 4 nanosecond pulse having a 0 dBm full bandwidth peak power operating in the 15.205 non-restricted bands.

Example (a) is legal under the new UWB rules (§15.501). It has a peak power spectral density of 0 dBm/50 MHz or -34 dBm/MHz. (Assume the pulse rate is low enough to satisfy the average power requirement.)

Example (b) is legal under previous Part 15 rules with a peak and average power spectral density of -41.25 dBm/MHz.

Example (c) is illegal under both § 15.501 *and* previous Part 15 rules (as recently interpreted by OET). Its measured peak power spectral density, however, is only -44.4 dBm/MHz.

Thus, while illegal, Example (c) has the lowest power spectral density! Interestingly, if one now ADDS the signal of Example (a) to the signal of Example (c), it suddenly

becomes legal! In other words, simply adding 2 GHz of broadband noise to a less interfering, **but** illegal signal, makes the new signal legal.

Conclusion

In summary, pulse desensitization correction (PDC) was used by Hewlett Packard (and radar) engineers to determine the true, full bandwidth peak power from measurements made with a modern spectrum analyzer (HP Application Note 150-2). It allows the engineer to determine total peak power from measurements of the power spectral density (i.e., Watts per Hertz bandwidth) in a given resolution bandwidth. From an interference perspective, however, full bandwidth peak power is irrelevant, as it is only the energy (power) received within the victim receiver's bandwidth that causes interference. This, of course, is precisely what the spectrum analyzer measures without the need for PDC.

In its **Petition for Reconsideration**, and in a subsequent *ex parte* presentation, MSSI pointed out the serious inconsistency between requiring the application of PDC above 1 GHz and the new UWB regulations. An additional example of the problems which this interpretation causes was provided above. Specifically, adding marry hundreds of MHz worth of noise to a signal which happens to fail Part 15 on account of pulse desensitization correction, now makes the signal legal, and it can *now even operate in previously restricted bands!*

The solution to this dilemma is obvious and consistent with the vast record in this proceeding and in the deliberations leading up to the introduction of §15.35. Thus, the FCC should remove the requirement for pulse desensitization correction for

measurements made above 1 GHz. Note that, in doing so, the peak power density will still remain limited to 20 dB above the maximum average power density.



LEVENTHAL SENTER & LERMAN PLLC

December 30, 2002

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Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
345 12th Street, SW
Washington, DC 20554

Re: Written Ex Parte Presentation in ET Docket 98-153

Dear Ms. Dortch:

The U.S. GPS Industry Council ("Council"), through undersigned counsel, and pursuant to Section 1.1206 of the Commission's Rules, 47 C.F.R. Sec. 1.1206, provides the following comments in support of the Petition for Reconsideration submitted by Multispectral Solutions, Inc. ("MSSI") in the above referenced docket.

In its Petition, MSSI requests that the Commission add appropriate language to Section 15.35 of its Rules removing the requirement for pulse desensitization correction ("PDC") above 1 GHz. MSSI argues in its Petition that removing the requirement for PDC above 1 GHz would encourage the use of existing *non-restricted* spectrum by new digital technologies (such as UWB), thereby further protecting the viability of GPS and other safety-of-flight/safety-of-life services that operate in the lower frequency bands.

Furthermore, rather than encouraging UWB operation to occur in previously restricted (*see* 47 C.F.R. § 15.205) bands of operation (as noted in the present UWB Report and Order), MSSI's recommendation would provide incentive for UWB equipment manufacturers to build devices that operate in non-restricted bands in the upper microwave frequencies (e.g., 5.46 – 7.25 GHz, 8.50 – 9.0 GHz, 9.5 – 10.6 GHz). The proposal would also pave the way for the responsible advancement of new digital wireless technologies without damaging the noise floor due to unlicensed density of operations in spectrum that has been protected for decades because critical national security and public safety services require operational predictability – lives depend on it.

Ms. Marlene H Dortch
December 20, 2002
Page -2-



For the reasons set out in MSSI's Petition, the Council supports strongly MSSI's requested change in the Commission's rules and urges the Commission to adopt these minor changes in this proceeding. We file an original and one copy of this letter with electronic copies to the parties listed below.

Sincerely,

Raul R. Rodriguez
Counsel to The U.S. GPS Industry Council

RRR:rjc

cc by e-mail: Dr. Robert Fontana
Dr. Edward Thomas
Dr. Julius Knapp
Mr. John Reed
Ms. Karen Rackley

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001



Reply to the Attn of MT

February 5, 2003

Dr. Robert J. Fontana
President
Multispectral Solutions, Inc
20300 Century Boulevard
Germantown, MD 20874

Reference: FCC ET Docket 98-153 Ultrawideband Transmission Systems

Dear Dr. Fontana:

The National Aeronautics and Space Administration (NASA) has reviewed the Petition for Reconsideration ("Petition") submitted by Multispectral Solutions, Inc. (MSSI) in the above referenced proceeding (see Enclosure 1). Specifically, your company has requested that the FCC add appropriate language to §15.35 of the Commission's Rules removing the requirement for pulse desensitization correction (PDC) above 1 GHz.

While a seemingly simple request, MSSI's Petition has far reaching consequences for the responsible introduction of UWB devices into the commercial marketplace. In particular, removal of the requirement for PDC above 1 GHz would encourage the use of existing, *non-restricted* spectrum by new digital technologies (such as UWB), thereby further protecting the viability of GPS and other safety-of-flight/safety-of-life services.

Furthermore, rather than encouraging UWB operation in previously restricted (15.205) bands as noted in the present UWB Report and Order (R&O), MSSI's recommendation would provide incentive for UWB equipment manufacturers to utilize non-restricted bands in the upper microwave frequency bands (e.g., 5.46 – 7.25 GHz, 8.50 – 9.0 GHz, 9.5 – 10.6 GHz). MSSI's proposal would also pave the way for the advancement of new digital wireless technologies without encroaching upon spectrum that is important to national security, public safety and science.

The MSSI Petition also addresses the dilemma associated with proposed relaxation of UWB emission constraints in the 960 to 1610 MHz region. From test data available to date, we believe that such a relaxation is inconsistent with the goal of protecting safety-of-life/flight systems. MSSI's Petition provides a workable compromise by allowing UWB technology to advance without necessitating a change to the current UWB R&O. Enclosure 2 contains our recommendations for changes to §15.35.

If you have any questions concerning this matter please contact Mr. James E. Hollansworth at (216) 433-3458 or e-mail jhollansworth@grc.nasa.gov.

Sincerely.

A handwritten signature in black ink, appearing to read "D. Struha".

David P. Struha
NASA IRAC Representative
Office of Space Flight

Enclosures

Cc:

NASA HQ/M/R.Spearing

/M/D. Srruba

/M/J. McNeff

/M/J. Rush

/M/L. Knight

/G/S. Mirmina

NASA Glenn/6140/W. Whyte, Jr., MS 54-2

/6140/J.Hollansworth, MS 54-2

/6140/P. Lowry, MS 54-2

/6140/R. Spence, MS 54-2

/6140/Official Files

Enclosure 1

Clarification of Pulse Desensitization Correction (PDC) Factor

Rod Spence
NASA Glenn Research Center

The PDC factor is used in the measurement of pulse modulated sinusoidal signals in order to correct for the finite resolution bandwidth (RBW) of the spectrum analyzer when estimating the peak envelope power of the signal. The meaning is best understood by example. Figure 1 shows a uniform pulse modulated sinusoidal signal with the following parameters:

pulse width $\tau = 20$ nanoseconds (ns)
pulse amplitude $A = 1$ volt
carrier frequency $f_0 = 1$ GHz
interpulse period $T_p = 200$ ns
pulse repetition frequency = PRF = $1/T_p = 5$ MHz
duty cycle = DC = $\tau/T_p = 0.1$ (10%)

The peak envelope power of this signal is simply $P_{peak} = A^2/2 = 0.5$ Watts and the total average power is $P_{peak} \times DC = 0.05$ W.

Figure 1a. Uniform Rectangular Pulse Modulated Sinusoidal Signal

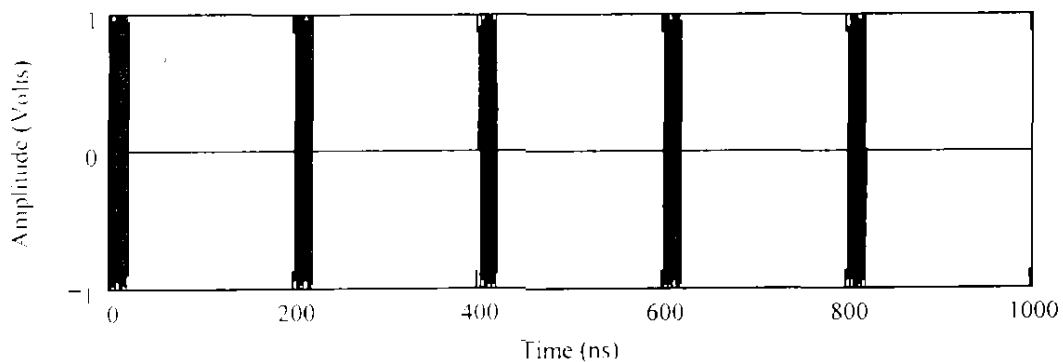
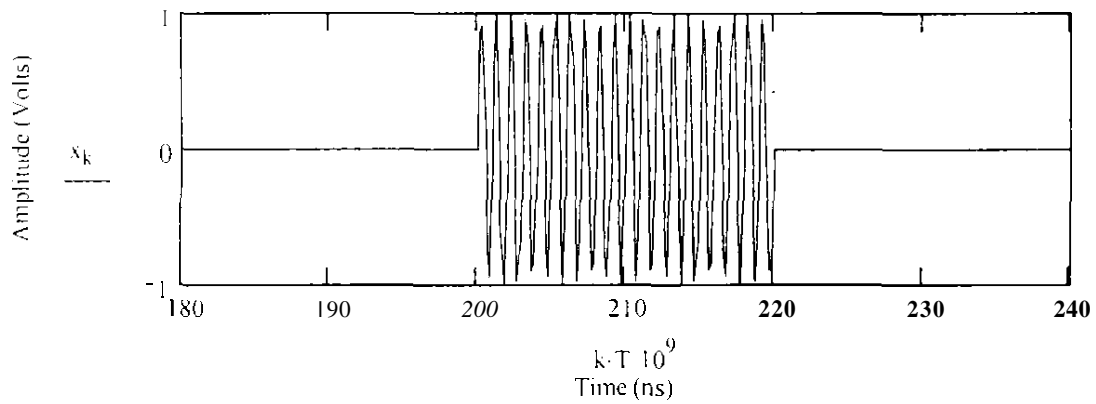


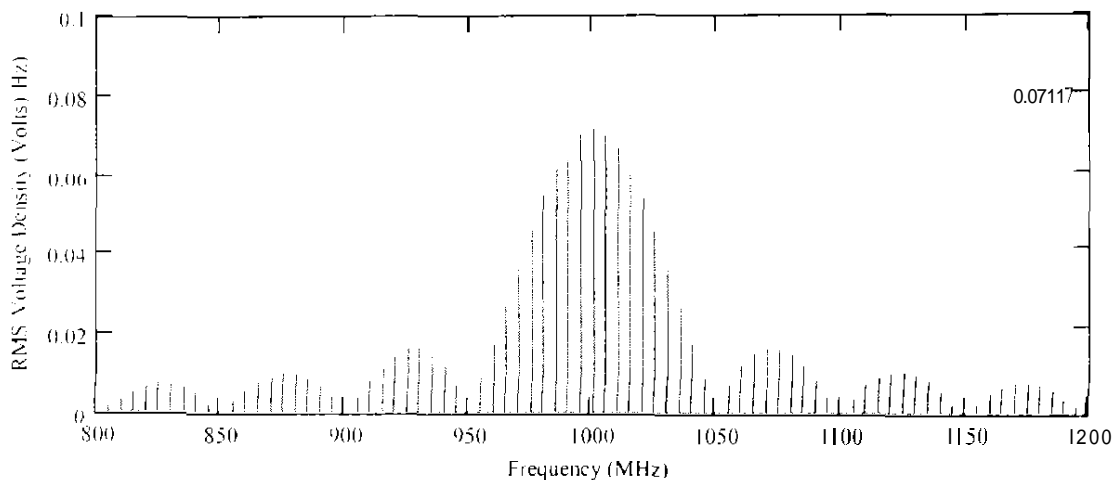
Figure 2a. Close-up of one of the sinusoidal pulses (20 ns pulse at 1 GHz carrier frequency)



Note that since this signal is a periodic signal ($T_p = 200$ ns) it can be represented in a Fourier series in the frequency domain. Its spectrum then consists of discrete spectral lines centered about the carrier frequency (1 GHz) as shown in Figure 2. Note that the spectral lines are spaced by the PRF (5 MHz) and that the nulls in the envelope occur at integer multiples of $1/\tau = 50$ MHz. The total average power of this signal can be found by summing over all spectral lines. The peak rms voltage level is given by:

$$V_{peak} = \frac{A}{\sqrt{2}} \cdot DC = \frac{A}{\sqrt{2}} \cdot \tau \cdot PRF \quad (1)$$

Figure 2. Line Spectrum of Pulse Modulated Sinusoidal Signal



For the values above, this yields $V_{peak} = 0.707$ V. Now suppose I'm measuring this signal with a spectrum analyzer whose resolution bandwidth is $RBW = 1$ MHz. Since the spectral lines are spaced 5 MHz apart, I can only observe one spectral line at a time. This is true

so long as the RBW is less than the PRF. The question then arises. “How can I estimate the peak envelope power of the signal given that I can only observe one spectral line at a time?” We see that since the **peak** envelope power is $A^2/2$ and the peak rms voltage we can observe on a spectral line is given by (1), we can compute the peak power from:

$$P_{peak} = V_{peak}^2 \cdot (\tau \cdot PRF)^{-2} = A^2 / 2 \quad (2)$$

where the factor $(\tau \cdot PRF)^{-2}$ is the appropriate correction factor when the RBW is less than the PRF.

When the RBW is greater than the PRF, the individual spectral lines can no longer be observed and the spectrum is approximated by the continuous envelope shown in Figure 3. The peak rms voltage level is now given by:

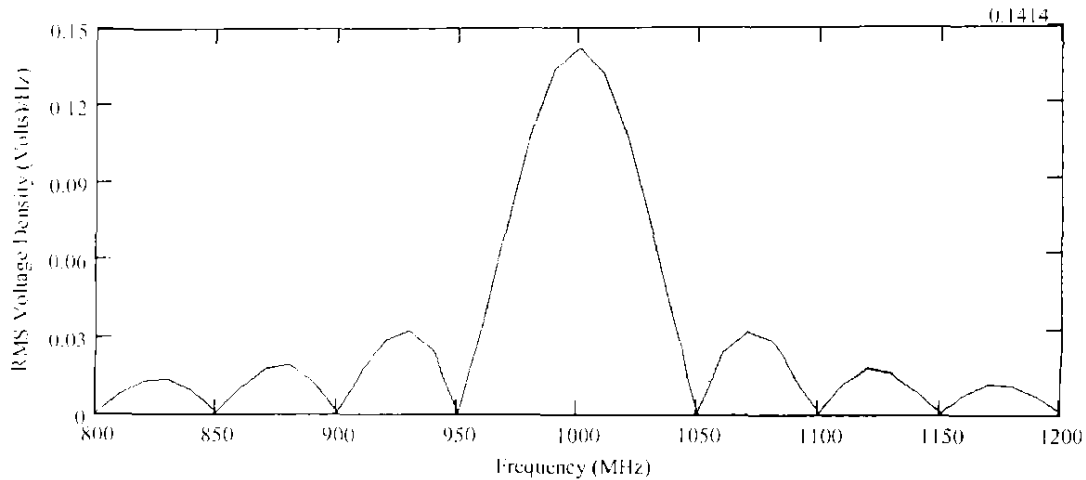
$$V_{peak} = \frac{A}{\sqrt{2}} \cdot \tau \cdot RBW \quad (3)$$

Thus, under this condition, we estimate the peak envelope power from:

$$P_{peak} = V_{peak}^2 \cdot (\tau \cdot RBW)^{-2} = A^2 / 2 \quad (4)$$

where the factor $(\tau \cdot RBW)^{-2}$ is now the appropriate correction factor.

Figure 3. Spectrum of Pulse Modulated Sinusoidal Signal When $RBW > PRF$



Because UWB signals do not use a CW carrier and also typically use non-rectangular pulses much shorter than those of a pulsed sinusoid, their spectrum looks much different than that shown in Figure 2. Apart from this, when looking at interference potential, it doesn't make sense to apply a PDC factor to estimate total radiated peak power (or total average power) across the entire UWB signal bandwidth since interference will be determined by the fraction of total power and portion of the power spectrum that falls in the victim receiver passband (which typically will be orders of magnitude smaller than the UWB bandwidth). Hence, there is no need to use a PDC factor on measurements of UWB signals in assessing potential UWB interference.

Enclosure 2

Recommended Change to Sec 15.35

Sec 15.35 Measurement detector functions and bandwidths

(b) On any frequency of [sic] frequencies above 1000 MHz, the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified in the regulations, including emission measurements below 1000 MHz, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules in this part, e.g., see Sec. 15.255. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. **Pulse desensitization correction should not be applied to measurements made above 1000 MHz.** Measurement of AC power line conducted emissions are performed using a CISPR quasi-peak detector, even for devices for which average radiated emission measurements are specified.

Before the
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Washington, D.C. **20554**

In the Matter of:)

Revision of Part 15 of the Commission's
Rules Regarding Ultra-Wideband
Transmission Systems

ET Docket No. 98-153

Reply Comments of Preco Electronics, Inc.

Filed by: Preco Electronics, Inc.
415 N. Maple Grove
Boise, ID 83704
(208) 323-1000

Date: January 3, 2003

Preco Electronics, Inc. respectfully submits the following reply comments in support of the "Petition For Reconsideration" submitted by Multispectral Solutions, Inc (MSSI) and received into the ECFS on June 18, 2002. as well as MSSI's "Petition For Reconsideration (Reply Comments)" received into the ECFS on July 29, 2002.

For over 50 years Preco Electronics has offered a wide variety of safety products targeted towards the commercial vehicle industry. One of Preco's newer products is a line of low-powered, short-range, object-detection radar systems capable of detecting both stationary and moving objects. These radars are simple pulsed carrier, and as a result Preco has had ample experience with Part 15 compliance testing in regards to pulsed emissions.

Pulse Desensitization Correction

The FCC's shifting interpretation of §15.35, so clearly described in MSSI's discussion of pulse desensitization correction (PDC), is particularly relevant to Preco's radar products and has had a profound effect on the ability of Preco to both demonstrate compliance and to retain the capability of building a usefully functional device. Not only has the FCC recently decided to require application of full-bandwidth

PDC calculations at the fundamental emission (well above 1 GHz), but now also at the band edges (i.e., §15.245, §15.249, etc.), and at all harmonics of the fundamental emission. Full bandwidth PDC at band edges and harmonics constrains pulse spectral emission operation to be well below the otherwise clearly stated Part 15 peak and average power limits and results in costly unnecessary filtering and performance reduction via unnecessary power reduction in the fundamental lobe

The changes in the FCC's interpretation of §15.35 have progressed as the FCC has decided rely more and more upon the theoretical concepts developed in the well known 1971 Hewlett Packard Application Note 150-2 (see MSSl's Reply Comments for footnote reference and related comments). At first glance, this may seem like a good thing since the application note does an excellent job of describing how to accurately make pulse spectral measurements using a spectrum analyzer. This is obviously crucial to accurately evaluating pulsed device emissions. Unfortunately, the FCC carried it too far by adopting the full bandwidth peak power concepts described in the application note to be used as the method of "measuring" the pulse peak power emission levels (this cannot actually be directly measured with any standard spectrum analyzer for most pulsed operation above 1GHz, only calculated). The FCC then declares that this calculated value for theoretical peak power is the emission level which must meet the peak power limits stated in Part 15 – at the fundamental, at the band edges, and at all harmonics.

MSSl beautifully and succinctly summarized why blanket PDC above 1 GHz is unreasonable with the following text found in their "Petition for Reconsideration (Reply Comments)" :

"From an interference perspective, however, full bandwidth peak power is irrelevant as it is only the energy (power) received within the victim receiver's bandwidth that causes interference."

It is the victim receiver's bandwidth that defines the interference potential. Put in other words, it is the emission power spectral density that needs to be measured and controlled to rationally protect against unintentional interference. MSSl clearly demonstrates that §15.35 was already doing this prior to the recent requirement for PDC above 1 GHz

From HP Application Note 150-2, we know that a victim receiver bandwidth must be about equal to or greater than $\frac{1}{2}$ of the fundamental main lobe bandwidth in order to "see" the pulse peak power (a transient lasting the length of the pulse and repeating at the pulse repetition frequency) Otherwise, the

victim receiver will receive only a portion of the pulse spectral lines. The portion of pulse spectrum received is obviously proportional to the victim receiver bandwidth. This is why an ordinary spectrum analyzer cannot directly measure a pulse's peak transient power for many devices utilizing pulsed carrier operation above 1 GHz. This is why HP Application Note 150-2 was written and targeted towards radar designers to help them understand how to use a spectrum analyzer to characterize their radar pulses. A radar pulse must be in the nanoseconds time domain to provide reasonable range resolution. A 100 nanosecond pulse covers approximately 100 feet in space and has a main lobe bandwidth of 20 MHz. Most ordinary spectrum analyzers top out at about 3 MHz, and most radar pulses are considerably shorter than 100 nanoseconds.

Ordinarily, a receiver's bandwidth is made as small as is practically possible in order to both exclude undesired signals and to reduce the thermal noise floor, which is of course directly proportional to the receiver's bandwidth. A very sensitive receiver will by necessity have a very narrow bandwidth, and will be capable of receiving only one or a very small number of potentially interfering pulse spectral components. The limits set forth in Part 15 already adequately protect these sensitive receivers by measuring peak power spectral density in a minimum 1 MHz bandwidth. These receivers cannot ever experience even a fraction of the full bandwidth transient pulse peak power. The more wideband the pulsed emission spectrum, the lower the power of the few individual spectral components which might be received in a sensitive victim receiver.

Preco Electronics welcomes the FCC's direction to use HP Application Note 150-2 as a basis for making accurate spectral measurements of the pulse spectral components. These components are CW in time as long as the pulse is active and are therefore equal in peak and average value individually. However, Preco **strongly** agrees with MSSl that the full bandwidth theoretical peak power calculation has no relevancy, and that the original intent of §15.35 very adequately accounts for emissions above 1 GHz by requiring measurement using a peak detector with a bandwidth of 1 MHz or greater. This measurements provide a normalized peak power spectral density that is unbiased, has a long history of proven adequacy, and provides an accurate indication of interference potential that is **easily** understood.

Vehicular Radar Restriction

Preco Electronics also very strongly agrees with MSSl's position and comments in regards to the arbitrary restriction of mobile UWB devices in the 3.1 GHz to 10.6 GHz band. In their Petition for Reconsideration, MSSl makes the following statement:

"Thus it makes little sense for the FCC to restrict operation of low PRF devices, e.g. vehicular radars, in the same region of the spectra (e.g., 3.1 to 10.6 GHz) that it is considering for the use of high-speed communications devices which have been shown to have a significantly higher potential for interference."

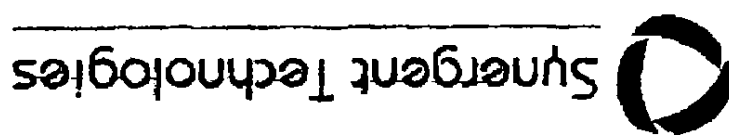
As long as the FCC resolves the conflict between the allowed UWB emission levels and the standard Part 15 emission levels by removing the requirement for PDC, and the requirements for reduced emission levels below 3.1 GHz are met, then there is no potential for a higher interference probability in a mobile UWB device than in any other allowed mobile Part 15 device.

This ruling is needlessly restricting innovation by requiring mobile UWB devices to operate in a region of spectrum where component costs are much higher and technical complications further increase cost and development time.

Respectfully submitted,

Brian Bandhauer

Senior RF Engineer
Preco Electronics, Inc



5301 Buckeystown Pike
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12 January 2003

Ms. Marlene H. Dorich
Secretary

Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Written Ex Parte Presentation in ET Docket 98-153

Dear Ms. Dorich:

I am providing the following comments in support of the Petition for Reconsideration submitted by Multispectral Solutions, Inc. ("MSSI") in the above referenced docket.

I am the author of Agilent Technologies' application note entitled "Radar Pulse

Measurements with a Spectrum Analyzer". This document is referenced in Agilent

Measurement Solutions - Issue 1, Volume 3¹ to assist Agilent customers in the proper

use of a spectrum analyzer to measure wideband pulse parameters. Please note that

Agilent now refers its customers to this document to better understand the phenomenon

of pulse desensitization. The predecessor document, HP Application Note 150-2

"Spectrum Analysis of Pulsed RF", is no longer in print but is currently scheduled for

revision. I am working with Agilent to update the entire 150 series of application notes.

Also, I was the co-author of three one-day seminars presented by Agilent: "Radar

Measurement Basics", "Advanced Radar Measurements", and "Digital Communication

Measurements". Each of the seminars has been delivered at over 35 sites worldwide. I

have personally delivered each of the seminars twenty times to over 1000 engineers.

As an expert in the field of spectrum analysis and wideband measurements with over 25

years of experience, 20 years with HP/Agilent in the development of test equipment and

procedures for wideband signals, I believe that I am eminently qualified to comment on

the correct use of pulse desensitization correction (PDC).

Specifically, I agree with the argument made by Multispectral Solutions, Inc. (MSSI) in

its Petition for Reconsideration that PDC is *not* required to determine the potential

interference effects of a wideband pulse waveform. Rather, pulse power density (i.e.,

http://www.toniid.agilent.com/pdf/andm_news.shtml

Ms. Marlene H. Dortch
12 January 2003
Page 2

Waus per Hz, dBm/MHz, etc.), whether determined on an average or peak basis, is the relevant parameter of importance.

Respectfully submitted,

A handwritten signature in black ink, reading "Randal J. Burnette". The signature is written in a cursive style with a large, stylized initial "R".

Randal J. Burnette
Founder and President
Synergent Technologies, Inc.
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USA